



## Origins of Life

### *Chemical Evolution*

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Image courtesy Jesse Lefkowitz

**J**ust as life has evolved into a plethora of different forms over an extended time period, the chemical elements which are the building blocks of matter have also, in a sense, evolved since the origin of the universe. Chemical evolution is essentially the process by which increasingly complex elements, molecules and compounds developed from the simpler chemical elements that were created in the Big Bang.

Recent astronomical observations have discovered that chemical evolution has even led to the synthesis of complex organic molecules in space, a discovery that could have serious implications on current theories of how life developed. But before we discuss the implications of organic compounds being formed in space, we must first outline the chemical history of the universe.

The chemical history of the universe began with the generation of simple chemicals in the Big Bang. Hydrogen and helium, the two lightest chemical elements, were and still are the most abundant elements in the universe. All stars derive their energy through the nuclear fusion of these light elements into heavier elements. Once stars have exhausted their energy supply by converting all of their hydrogen to helium, the star cools and

contracts, with the increased pressure from the contraction initiating the fusion of helium to form carbon.

Depending on the size and density of the star, the fusion reactions can end with the formation of carbon or they can continue on to form all the elements up to iron. Eventually, the successive fusion reactions of heavy elements trigger the collapse and explosion, or supernova, of the star. These supernova explosions release the newly-formed elements into space, where they play roles in the formation of interstellar dust, meteoroids, planets and galaxies.



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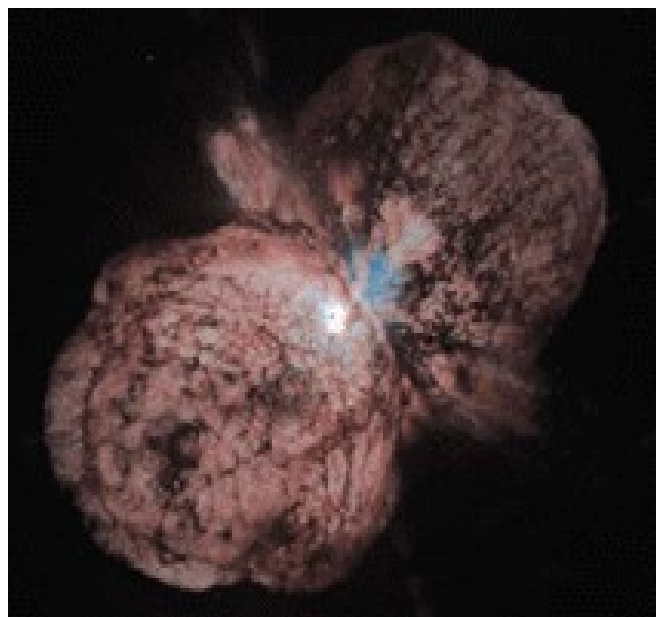
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By examining the composition of stars at various stages of their life, scientists can trace the chemical evolution of galaxies and get a clear picture of the early conditions of the universe. Techniques such as optical spectroscopy (which measures the intensities and wavelengths of light) gives these scientists the ability to peer back along the chemical evolutionary timeline and see some of the oldest material in the universe. In doing so, they have made some remarkable findings.

Astronomers recently discovered the existence of complex organic molecules called aromatic hydrocarbons in space. Small organic molecules were found to have evolved into complex aromatic molecules over a period of several thousand years. Although many scientists have long thought that life arose on primitive Earth from simple inorganic molecules, a theory supported by the Miller-Urey experiment, the discovery that organic molecules can be synthesized in space could serve to change popular theories for the development of life on earth. Because the elements and molecules synthesized by stars are eventually ejected into space, there is a chance that some of these molecules could have landed on Earth and triggered the development of life.

Chemical evolution is an exciting topic of study because it yields insight into the processes which lead to the generation of the chemical materials essential for the development of life. If the chemical evolution of organic molecules is a universal process, life is unlikely to be a uniquely terrestrial phenomenon and is instead likely to be found wherever the essential chemical ingredients are found.



The supernova Eta Carinae. Courtesy NASA.